

GRAYS REEF PASSAGE, MICH.

L E T T E R

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON
PRELIMINARY EXAMINATION AND SURVEY OF GRAYS REEF
PASSAGE, OFF WAUGOSHANCE, IN LAKE MICHIGAN, WITH A
VIEW TO REMOVING SHOALS AND DEEPENING PASSAGE.

APRIL 4, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be
printed, with illustrations.

WAR DEPARTMENT,
Washington, April 4, 1914.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief
Engineers, United States Army, dated 3d instant, together with
copies of reports from Lieut. Col. J. C. Sanford, Corps of Engineers,
dated December 27, 1912, and January 13, 1914, with maps, on pre-
liminary examination and survey, respectively, of Grays Reef Passage,
Mich., made by him in compliance with the provisions of the river
and harbor act approved July 25, 1912.

Very respectfully,

LINDLEY M. GARRISON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, April 3, 1914.

From: The Chief of Engineers, United States Army.

To: The Secretary of War.

Subject: Preliminary examination and survey of Grays Reef Passage,
Mich.

There are submitted herewith for transmission to Congress,
reports dated December 27, 1912, and January 13, 1914, with maps,

by Lieut. Col. J. C. Sanford, Corps of Engineers, on preliminary examination and survey, respectively, of Grays Reef Passage, off Waugoshance, in Lake Michigan, with a view to removing shoals and deepening passage, authorized by the river and harbor act approved July 25, 1912.

2. Grays Reef Passage lies between Grays Reef and Vienna Shoals in the northeasterly end of Lake Michigan, and is used by a large part of the commerce bound to and from the Straits of Mackinac. The passage is divided by Middle Shoal into an east and a west channel, of which the latter, having a general width of about 1,600 feet, is now generally followed. The deepest draft vessels can navigate this channel with safety during clear weather, but in thick weather the passage is difficult and dangerous. The total commerce through Grays Reef Passage during 1913 is reported as amounting to 19,960,000 tons, of which about 17,000,000 would be affected by the contemplated improvement. The district officer submits estimates of cost of providing channels 23 to 27 feet deep at standard low water both by way of the east and the west channels. He believes that a channel 25 feet deep below standard low water and 3,000 feet wide by way of the passage lying eastward of the Middle Shoal, at an estimated cost of \$175,000, will meet the needs of navigation, and in view of the magnitude of the traffic that would be affected and the reasonable cost of the work, he expresses the opinion that the locality is worthy of improvement to this extent. In this opinion the division engineer concurs.

3. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its accompanying report, dated February 24, 1914, concurring with the district officer and the division engineer.

4. After due consideration of the above-mentioned reports, I concur with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the improvement by the United States of Grays Reef Passage, off Waugoshance, in Lake Michigan, is deemed advisable to the extent of providing a channel 25 feet deep at standard low water and 3,000 feet wide by way of the east channel, as proposed by the district officer and shown on accompanying map, at an estimated cost of \$175,000, the full amount of which should be provided in one appropriation. No estimate for maintenance can be made at this time.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS ON SURVEY.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
February 24, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. This is a report of preliminary examination and survey of Grays Reef Passage, off Waugoshance, in Lake Michigan, with

view to removing shoals and deepening passage, as provided for in the act of July 25, 1912.

2. Grays Reef Passage is used by a large part of the commerce of Lake Michigan bound from or to the Straits of Mackinac. The passage is divided by a middle shoal into an east and west channel. The west channel is generally used by all deep-draft vessels which make the passage. The general width is about 1,600 feet, with a controlling depth of about $24\frac{1}{2}$ feet below standard low-water plane and a width of 1,100 feet. The deepest draft vessels can and do navigate the passage with safety during clear weather, but experience difficulty and danger during thick weather.

3. It is estimated by the district officer that about 24,270,000 tons of commerce passed through the Straits of Mackinac in 1913, of which amount about 19,960,000 tons passed through Grays Reef Passage. Of this latter amount about 17,000,000 tons were carried in vessels over 2,000 net tons capacity, which would all be beneficially affected by the improvement of the passage.

4. Estimates are presented for improvement both in the east and west channel, with varying depths and a width of 3,000 feet in the west channel and 3,000 and 4,500 feet in the east channel, as follows:

Depth below standard low water.	West Channel, 3,000 feet wide.	East Channel, 3,000 feet wide.	East Chan- nel, 4,500 feet wide.
<i>Feet.</i>			
23.....	\$83,000	\$18,000	\$188,000
24.....	220,000	60,000	357,000
25.....	421,000	175,000	668,000
26.....	836,000	450,000	1,202,000
27.....	1,595,000	1,126,000	2,179,000

The unit estimates of cost are necessarily high, due to the exposed position of the work, the character of the material to be excavated, and the shallow working face of the cuts. Considering the exposed location of this passage and the necessity of providing for the scend of the heavily laden vessels, the district officer believes that a depth of 25 feet below standard low-water plane is essential. He believes a width of 3,000 feet will be sufficient and that the best channel for improvement is that east of the middle ground.

In view of the magnitude of the traffic to be affected and the reasonableness of the cost, the district officer expresses the opinion, which the division engineer concurs, that the locality is worthy of improvement to the extent of providing a channel as indicated above, at an estimated cost of \$175,000. No estimate can be made at this time for maintenance and none may be required for several years.

The improvement contemplated is for the benefit of a very large traffic in heavily laden lake vessels which now go through Grays Reef Passage, subject at times to inconvenience and danger through lack of adequate width and depth. The amount involved in the proposed improvement is considered reasonable when compared with the probable benefits resulting therefrom, and therefore the board concurs in the views of the district officer and the division engineer, and reports that in its opinion it is advisable for the United States to undertake the improvement of Grays Reef Passage by the provision

of a channel 25 feet deep below standard low-water plane and 3,000 feet wide through the east channel of Grays Reef Passage, at an estimated cost of \$175,000, which amount should be made available in one appropriation.

8. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other subjects related to the project proposed that they may be coordinated therewith to lessen the cost and compensate the Government for expenditures made in the interests of navigation.

For the board:

FREDERIC V. ABBOT,
Colonel, Corps of Engineers,
Senior Member Present.

PRELIMINARY EXAMINATION OF GRAYS REEF PASSAGE, MICH.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., December 27, 1912.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army.

Subject: Grays Reef Passage, Mich.—Report on preliminary examination.

1. The following report on the preliminary examination of Grays Reef Passage, off Waugoshance in Lake Michigan, with a view to removing shoals and deepening passage, as provided in the river and harbor act approved July 25, 1912, is submitted in accordance with instructions contained in department letter of August 3, 1912.

2. Grays Reef Passage is the name applied to the narrows between Grays Reef and Vienna Shoal in the northeasterly end of Lake Michigan. It is the only deep-draft, navigable opening between the Straits of Mackinac and that portion of Lake Michigan lying easterly of Beaver, Fox, and Manitou Islands. The total width of the passage between the reefs projecting westerly from Waugoshance Point and easterly from Hog Island, respectively, is about $2\frac{1}{4}$ miles. This passage is divided and partially closed by numerous shoals, whose depths range from 16 to 25 feet. Soundings indicate that the bottom is rock in situ, strewn with boulders of considerable size. The most prominent of the shoals, including Middle Shoal, are near the center of the passage. To the westward of Middle Shoal there is a channel about 1 mile in width with least depth of $18\frac{1}{2}$ feet below low-water plane. This is the channel that has been used by the traffic through Grays Reef Passage since the draft of lake vessels exceeded the available depth on Middle Shoal. The increased draft of freight carriers and the lower lake stages of recent years have finally made the reef shoal near the center of the westerly passage a serious menace. The steamer *D. R. Hanna*, drawing 18 feet 10 inches, suffered serious injury by striking this obstruction on August 23, 1911. As a result of the casualty, the shoal is now permanently marked with a gas buoy and the present traffic passes between this gas buoy and Grays Reef light vessel, located at the extreme easterly point of Grays Reef. The available channel is now about 1,600 feet wide with a least depth of 25 feet at standard low water, which is about one-half foot below the lowest monthly mean stage of record.

3. Vessels approaching this passage from the southward shape a new course at the entrance to the narrow channel, and as location must be determined from Isle aux Galets Light about 6 miles south of the turning point, considerable difficulty is experienced in safely navigating the passage in thick weather. There is a similar difficulty, but to a less degree, in approaching from the northward when the aids to navigation are not clearly visible from a distance. The narrow channel and necessary shifting of the course while making the passage, together with the knowledge of the ragged rocky bottom and little room under the deep-laden boats, have discouraged many of the shipmasters from using the passage, particularly in thick or rough weather. In consequence, a large percentage of the traffic that would otherwise use this shorter route through Grays Reef Passage now uses the northerly route around Squaw Island.

4. The passage to the eastward of Middle Shoal was sounded in 1902, and the results of this survey show a channel about 4,000 feet wide with least depth of about 23 feet below standard low water. This passage has not been investigated with the sweep, and as the bottom is very irregular it is probable that the soundings do not reveal the least depths. So far as known no heavily laden vessel has attempted this easterly passage. It can not be recommended for use until thoroughly investigated with the sweep; and even if a survey developed no less depths than now known, this passage could only be used with great caution and under most favorable conditions on account of these limiting depths.

5. The route through Grays Reef Passage, between harbors on the southerly end of Lake Michigan and all Lake Superior and lower lake ports, is about 20 miles shorter than by the northerly route around Squaw Island. Furthermore, the route by Grays Reef Passage is fairly well protected by islands for a distance of 75 miles down Lake Michigan, and there are good harbors of refuge in the vicinity of Manitou Passage where this route enters the open lake at the lower end, both of which are important elements of time saving and safety that are not found on the other route.

6. There are no statistics that will give direct and definite information of the commerce through Grays Reef Passage. A general idea of the amount of traffic may be derived, however, from the statistics of commerce for the locks at Sault Ste. Marie, and for the Detroit River. In 1911, 4,500,000 tons of freight passed through St. Marys Falls Canal, bound to or from Lake Michigan ports. Of the 67,000,000 tons passing through the lower Detroit River, it is estimated that 5,500,000 tons stop at or start from Detroit, 47,000,000 tons go to or come from Lake Superior ports, and the remaining 14,500,000 tons are practically all carried to or from Lake Michigan. The total freight traffic passing through the Straits of Mackinac during 1911 is thus estimated to be 19,000,000 tons. Of this total tonnage, about 5,000,000 tons passed to or from Escanaba, and naturally could all move by the northern route. The vessels carrying the 1,000,000 tons of freight to and from other Lake Michigan ports could all use Grays Reef Passage to advantage, unless weather conditions were such as to cause traffic to seek the shelter of the west shore of Lake Michigan. I am advised that fully 90 per cent of this traffic (equivalent to about 12,500,000 tons of freight in 1911) would have passed through Grays Reef Passage if there had been a channel wide and deep enough to afford safe navigation under all conditions.

It is estimated that about 50 per cent, or 7,000,000 tons, of the freight bound to or from Lake Michigan ports below Green Bay actually passed through the passage in 1911. It is roughly estimated therefore that with freight traffic on the Lakes equivalent to that in 1911, an improved channel through Grays Reef Passage would afford a more sheltered route and a saving of 20 miles in distance for the transportation of 5,500,000 tons annually.

7. I am of the opinion that improvement by the Government is warranted if the cost thereof is reasonable. As the available data are not sufficient to make plans or estimates of improvement, a survey is recommended.

8. As the act providing for examination does not specify the depth or width of the channel contemplated for improvement, the desires of interested parties have been sought. In reply to inquiry of the Lake Carriers' Association, the president states that the consensus of opinion among shipmasters that have been consulted is that the passage "should present a clear depth of at least 25 feet and be a full mile more in width." A later communication from the same gentleman states that "at a meeting of some of our large vessel owners, recently held in Cleveland, this matter was discussed, and the consensus of opinion was that this channel should be 30 feet deep and a mile wide. The reason given for advising this greater depth is that the action of the ice through this passage is very apt to lodge in it bowlders whose presence is unknown until some vessel strikes one of them, and that although the channel may be clear at the time of sweeping to a depth of 25 feet, the lodging of one of these bowlders places a menace to navigation which previously did not exist; and the only way in which the latter survey (Government) can insure a clear depth of 25 feet is by making the passage 30 feet deep."

9. At a meeting of the committee on aids to navigation, Lake Carriers' Association, held in Detroit, Mich., on December 16, 1912, the question of improvement of Grays Reef Passage was discussed. The general opinion then expressed was that a channel 3,000 feet wide and 27 feet deep would afford ample room and depth for safe navigation so long as the full depth was maintained.

10. There are no questions of terminal or transfer facilities, water power, or other subjects relating to navigation to be considered in connection with the desired improvement.

J. C. SANFORD,
Lieutenant Colonel, Corps of Engineers.

[Second indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
January 27, 1913.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

For reasons stated herein, the board concurs with the district officer in recommending a survey in order to determine the extent and advisability of the improvement. It is requested that the report of the survey receive consideration by the division engineer.

For the board:

WM. T. ROSSELL,
*Colonel, Corps of Engineers,
Senior Member of the Board.*

SURVEY OF GRAYS REEF PASSAGE, MICH.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 13, 1914.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army
(Through the Division Engineer).

Subject: Survey of Grays Reef Passage, Lake Michigan.

1. The preliminary examination report on Grays Reef Passage, off Waugoshance, in Lake Michigan, with a view to removing shoals and deepening passage, as provided in the river and harbor act approved July 25, 1912, was submitted on December 27, 1912. This report, which recommended a survey in order to determine the feasibility of improvement and to prepare plans and estimates therefor, received favorable action by the Board of Engineers for Rivers and Harbors, and a survey was authorized on January 30, 1913.

2. Field work was deferred until midsummer, owing to the exposed location and the consequent delays that would probably be experienced in attempting work in this locality during the rough weather of the spring months. The field party assigned to the survey was engaged on this work from July 11 to August 14, 1913. This party, in its organization, experience, and equipment, was well adapted for the work, and, with the addition of a diver and his helper, the survey was undertaken and prosecuted thoroughly and expeditiously. The survey data, after reduction, are shown on the accompanying five sheets of plans, consisting of one general and four detail maps of Grays Reef Passage.

3. As stated in the report on preliminary examination, Grays Reef Passage is divided by Middle Shoal into an east and west channel. The westerly portion of the west channel is now marked by aids to navigation and is used by all the deep-draft vessels which make the passage. The general width between shoals is about 1,600 feet, and the controlling depth for a width of 1,100 feet is about $24\frac{1}{2}$ feet below standard low water plane (which plane is 578.50 feet above sea-level and 0.48 feet below the lowest monthly mean water level of record in Lake Michigan). The deepest laden boats on the lakes can and do navigate the passage with safety during clear weather; but, owing to its limited width and the fact that a change in course is necessary at the southerly entrance to the channel, difficulty is experienced in making a safe passage in thick weather. This condition was apparent before the survey was made. The east channel is now determined to have a clear depth of about 23 feet (standard low water) and a width, for this depth, of about 2,000 feet. There is considerably more room than in the west channel, but the depth, in my opinion, is not sufficient to insure safety in a heavy seaway.

4. The survey was made to cover both east and west channels with a view to determining the possibility of improving either, and to making comparative estimates of cost. The elevations of the bottom were determined in detail from the shoalest depths to depths of 27 feet below standard low water by means of soundings, the location of limiting depths and the minimum depths on the shoals were verified with the sweep or drag, and the character of the bottom and underlying material was ascertained by a diver. The bottom was thor-

oroughly examined and frequent probings were made. Dynamite was also used in a few places on the higher shoals when the hardness of the bottom otherwise prevented examination of underlying material to the depth of possible improvements.

5. Contrary to the opinion expressed in the preliminary examination report the bottom was nowhere found to be solid rock. For the most part it consists of cobblestones and small bowlders firmly embedded in gravel and overlying a stratum of marl 6 inches to 4 feet in thickness. There are occasional patches of loose bowlders scattered over the shoal areas. The largest bowlder found was estimated to be about 4 feet in diameter, but the average size is from 1 to 2 feet. The marl consists of sand cemented with lime, and is very hard while in place. When removed it crumbles rapidly in water, but hardens in the air until it resembles soft sandstone. In a few places the marl appears at the surface, lacking the usual covering of cobblestone and gravel. At all points where the probing penetrated the marl there was found an underlying stratum of sand and fine gravel extending down to the full depth of 27 feet below standard low water plane. It was ascertained with reasonable certainty that there is no solid rock in either channel above this depth.

6. Examination of the west channel indicated that improvement to a width greater than about 3,000 feet would involve excavation through large shoal areas that border on both sides, and the cost would increase very rapidly with increased widths. In my opinion a channel 3,000 feet wide, properly buoyed and lighted, will afford ample room for safe navigation under all conditions, and it may be noted that this opinion accords with that expressed by the committee on aids to navigation of the Lake Carriers' Association, as noted in the preliminary examination report. Accordingly, estimates have been prepared, and are herewith submitted, covering possible improvement of either the east or west channels to a width of 3,000 feet, and for depths ranging from 23 feet to 27 feet below standard low-water plane. Additional estimates contemplating improvement of the east channel—for the same depths—to a width of 4,500 feet are also submitted. This greater width is feasible in the east channel, but is not considered necessary or advisable at the present time. The estimates are presented for consideration and for use if a greater width shall prove desirable in the future.

7. The estimated quantities and costs are as follows:

	Depths below standard low-water plane.				
	23 feet.	24 feet.	25 feet.	26 feet.	27 feet.
West Channel, 3,000 feet wide:					
Excavation to depth.....cubic yards..	7,213	20,943	53,538	121,693	258,800
Pay material in 2 feet overdepth.do....	15,407	46,260	90,296	192,407	387,500
Total.....do.....	22,620	67,203	143,834	314,100	646,300
Scow measurement (118 per cent).do....	26,692	79,300	169,724	370,638	762,700
Unit cost.....dollars..	2.75	2.50	2.25	2.05	1.75
Cost of excavation.....do....	73,403	198,250	381,879	759,808	1,440,200
Contingencies.....do....	9,597	21,750	39,121	76,192	145,700
Aggregate cost.....do....	83,000	220,000	421,000	836,000	1,585,900

	Depths below standard low-water plane.				
	23 feet.	24 feet.	25 feet.	26 feet.	27 feet.
West Channel, 3,000 feet wide:					
Excavation to depth.....cubic yards..	1,008	4,480	15,768	50,161	133,887
Pay material in 2 feet overdepth.do....	3,260	11,889	37,111	103,593	279,185
Total.....do....	4,268	16,369	52,879	153,754	413,072
East Channel, 4,500 feet wide:					
Excavation to depth.....cubic yards..	22,455	47,698	97,574	194,725	372,707
Pay material in 2 feet overdepth.do....	34,926	69,296	136,036	256,704	510,778
Total.....do....	57,381	116,994	233,610	451,429	883,485
Scow measurement(118 per cent).do....					
Unit cost.....dollars..	67,710	138,053	275,660	532,686	1,042,512
Cost of excavation.....do....	2.50	2.35	2.20	2.05	1.90
Contingencies.....do....	169,275	324,425	606,452	1,092,006	1,980,773
Aggregate cost.....do....	18,725	32,575	61,548	109,994	198,227
Aggregate cost.....do....	188,000	357,000	668,000	1,202,000	2,179,000

Summary—Comparison of estimates.

Depth below standard low water.	West Channel, 3,000 feet wide.	East Channel, 3,000 feet wide.	East Channel, 4,500 feet wide.
<i>Feet.</i>			
23.....	\$83,000	\$18,000	\$188,000
24.....	220,000	60,000	357,000
25.....	421,000	175,000	668,000
26.....	836,000	450,000	1,202,000
27.....	1,595,000	1,126,000	2,179,000

8. The material to be excavated in the improvement of either the west or east channel appears to be such that it can practically all be handled with a dipper dredge without blasting, although there may possibly be some boulders whose removal will require the use of aerrick scow. The dredging will be somewhat difficult, however, due to the hardness of the material and the small working face that will be presented. A large portion of the cut in all cases will be only 2 to 4 feet in depth. The unit costs in the above estimates are adopted with a consideration of this difficulty of dredging and also of the probable delays on account of the exposed location of the work and of the risk to dredges and other floating plant, due to the distance (15 to 20 miles) from the nearest harbors.

The allowances for contingencies in the above estimates are in general from 10 to 12 per cent and are intended to cover the costs for engineering, inspection, and office expenses. Such expenses will necessarily be high, owing to the remote location of the work and the difficulties in reaching the site of operations.

9. Practically all of the commerce through Grays Reef Passage passes through either St. Marys River or Detroit River, and is limited in draft to the available depths in these rivers. The present project for improvement of lower Detroit River contemplates a clear depth referred to standard low-water plane, of 21 feet. The available depth in St. Marys River, referred to the same plane, is about 20.5

feet. Considering the exposed location of Grays Reef Passage, it is estimated that an excess depth of between 3 and 4 feet below the ordinary draft of a steamer is necessary to safely allow for rolling and pitching during extremely rough weather. It is my opinion, therefore, that any project for improvements in Grays Reef Passage should contemplate a channel 25 feet deep below standard low-water plane.

10. An attempt has been made to obtain further data regarding traffic through Grays Reef Passage. A record was kept of passing boats during the period covered by the survey, and by comparison with passages through the Straits of Mackinac during the same period and the proportion of traffic at Sault Ste. Marie in 1912, during the similar period as compared with the traffic for the entire year, the following estimates have been derived:

	Tons.
Commerce through the Straits of Mackinac, 1913	24,270,000
Commerce of northern route (north of White Shoal), 1913.....	4,500,000
Commerce through Grays Reef Passage, not passing through the Straits, 1913.....	190,000
Total commerce through Grays Reef Passage, 1913.....	19,960,000

Of this latter amount, it is estimated that 16,350,000 tons (of 2,000 pounds) was carried in boats of over 2,000 net tons capacity, which would all be beneficially affected by improvement of the passage. A portion of the traffic now taking the northern route would undoubtedly use Grays Reef Passage if a wide, clear channel were provided. The improvement of the passage may be said, therefore, to affect commerce aggregating about 17,000,000 tons, as of 1913, and this amount will increase with the increase of commerce on the lakes and particularly with that of the rapidly growing commerce and from southern Lake Michigan ports.

11. The proportion of Lake Michigan commerce that used Grays Reef Passage in 1913 greatly exceeded that of 1911. This was principally due to the restored confidence in the safety of the channel after the placing of a gas buoy on the shoal upon which the steamer *Hanna* had suffered serious damage in 1911. The buoy was established by the Lighthouse Bureau at the opening of navigation in 1912 and has been maintained since then.

12. In view of the magnitude of the traffic that would be affected and considering the cost of improvement, it is believed that Grays Reef Passage is worthy of improvement and that provision therefor should be made at an early date. It is recommended that the improvement shall consist of a dredged channel 25 feet deep below standard low water plane (corresponding to a depth of about 25½ feet at mean low water), and 3,000 feet wide, such depth and width being considered suitable for boats of a maximum draft of 22 feet for which the channel is designed. It is further recommended that the improved channel shall be located in the deepest portion of the passage lying eastward of Middle Shoal, with the center line direct on White Shoal Lighthouse.

The estimated cost is \$175,000, and it is considered desirable that the initial appropriation shall provide the full amount. So far as can be foreseen at present, there will be no cost for maintenance for several years at least. While it may be necessary to restore

portions of the channel at some future time, it is impracticable to estimate now when such restoration will be necessary or what the cost may be.

J. C. SANFORD,
Lieutenant Colonel, Corps of Engineers.

[First indorsement.]

OFFICE DIVISION ENGINEER, LAKES DIVISION,
Buffalo, N. Y., February 3, 1914.

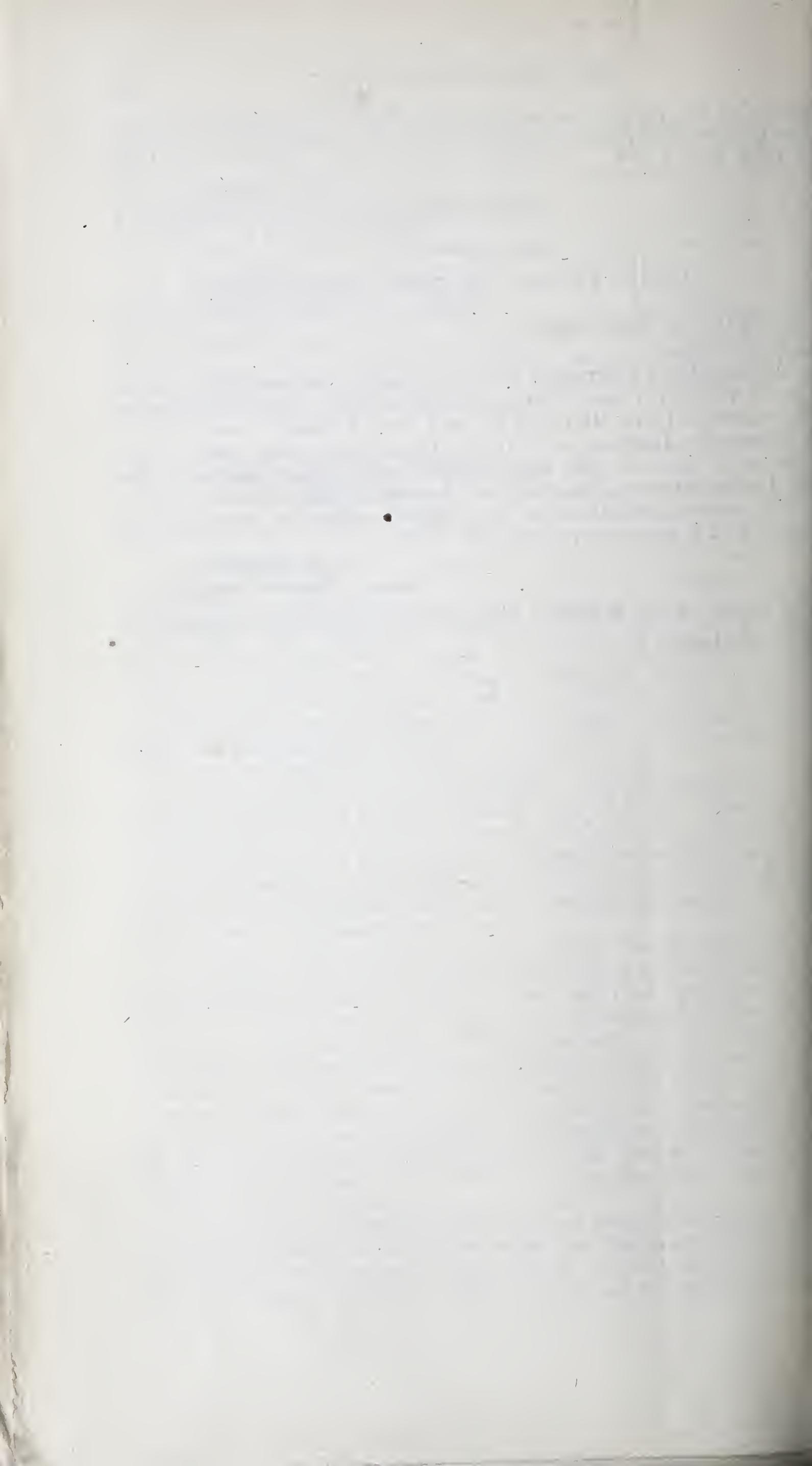
to the CHIEF OF ENGINEERS.

1. Forwarded.
2. As stated in paragraph 5 of the preliminary examination report the route via Grays Reef Passage is preferred by vessel interests for traffic through Lake Michigan to and from Chicago, Gary (Ind.), and Milwaukee Harbors, and due to its extensive use, may be regarded as a part of the ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo.
3. The recommendations of the district officer as expressed in paragraph 12 herein are concurred in.

J. G. WARREN,
Colonel, Corps of Engineers.

[For report of the Board of Engineers for Rivers and Harbors on survey, see page 2.]





Soundings in feet are reduced to Standard Low Water Plane when T. Lake Michigan is 378.50 feet above mean tide at New York. Reductions have been determined from the record of the automatic gauge at Mackinac City and applied on the elevation at B. M. A (See page 2740 Report of the Chief of Engineers U.S. Army 1903).

2741 contours represented thus

2511

Shaded Areas show extent of dredging to provide a channel 1000 feet wide and 25 feet deep below Standard Low Water Plane, as recommended in accompanying report.



GENERAL MAP INDEX SHEET

U S Engineer Office
Grand Rapids, Mich Jun 13 1914
Transmitted to this War Engineer,
U S Army, your report of this date.

Approved *W. H. Ford*
Lieut. Col. Corps of Engineers, U S Army.

Forwarded by S. H.
Transmitted by S. H.
Checked by S. H.
Reviewed by S. H.



